SOIL CONSERVATION

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IMPRESSIONS OF THE THIRD INTERNATIONAL SOIL SCIENCE CONGRESS

By W. C. Lowdermilk[1]

Significant advances in pedology, or soil science, were noted at the Third International Congress of Soil Science. The congress brought together in England more than 400 delegates from 40 countries at the ancient University of Oxford for its sessions from July 30 to August 7. Following the congress, an excursion was made by a number of the delegates, from August 8 to 23, to examine and discuss soil conditions in England, Wales, and Scotland. Out of a wide range of subjects presented at plenary and division meetings, papers describing the hitherto little known soils of Africa and reporting advances in microbiology and soil formation were outstanding in interest.

This congress was the third general meeting of the International Society of Soil Science, which has grown to large proportions and importance within the past decade. It constituted a joint session of the six commissions of the society, each of which is devoted to a special phase of pedology. They are: Soil physics; soil chemistry; soil microbiology; soil fertility; soil genesis; morphology, and cartography; and application of soil science to land amelioration.

It is the practice for the commissions to hold interim meetings which serve to bring together pedologists with specialized interests more often than do the congresses. It will be recalled that the first congress was held at Washington, D. C., in 1927, and the second in Moscow in 1930.

The congress was opened at the Rhodes House, Oxford, by the president, Sir J. E. Russell, who is also the director of the renowned Rothamsted experimental station. After the address of welcome by the vice chancellor of the University of Oxford, the president delivered his address in which he reviewed advances in the science of pedology. A report on the work of the International Society of Soil Science since the second congress was given by Dr. D. J. Hissink, and on the publications of the society by the honorary editor, Prof. Dr. F. Schucht.

Plan of Procedure

The procedure of the congress was well designed for maximum benefit to members and delegates. Mornings were devoted to plenary sessions of each of the six commissions in turn, at which papers of general interest were read and discussed. Afternoons were given over to separate or joint sessions of the commissions and subcommissions. Papers delivered before plenary and commission sessions were printed in advance and made available for study before the

(Continued on page 15)

[1] An official delegate of the United States to the International Congress of Soil Science. Dr. Lowdermilk is Associate Chief of the Soil Conservation Service.

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VOLUNTARY ASSOCIATIONS GET UNDER WAY

Functioning in Alamance, Richmond, and Union Counties, N. C., are the first voluntary soil conservation associations to be formed under provisions of the Report of the Secretary's Committee on Soil Conservation. They are at the forefront of many similar organizations through which the erosion control program is to be administered during the next 2 years.

Group Responsibility

In this report made to Secretary Wallace the necessity of dealing with groups rather than individuals was emphasized. "We believe", it was stated, "that the Federal Government cannot manage erosion-control operations efficiently with hundreds of thousands of individual farmers, but that local group responsibility will have to be obtained through the organization of cooperative control associations or governmental agencies, which should be permanent in character and legally empowered to own and dispose of real estate, to lay assessments on their members, and otherwise to obtain compliance in a complete erosion-control program on the area owned or controlled by the members of the association. Nevertheless, we recognize that during the organization period of the Soil Conservation Service, and especially for the next few months, it may be necessary for a few E. C. W. projects to be undertaken outside of demonstration areas and on the lands of farmers not members of such legally constituted associations. However, even in the emergency period, the Department should at least require that such projects be handled through voluntary soil conservation associations."

In furtherance of this policy, it was recommended that on and after July 1, 1937, and sooner wherever feasible, all erosion-control work on private lands, including new demonstration projects, be undertaken only through legally constituted soil conservation associations or governmental agencies. Until that date, new E. C. W. erosion-control projects on private lands outside of demonstration areas, if not handled through legally constituted associations, will be undertaken only through voluntary associations, and then subject to the specific approval of the Secretary of Agriculture.

Three Units

Voluntary associations may be organized on the basis of an E. C. W. camp, a small watershed or a county, according to G. L. Crawford, acting head of Cooperative Relations. In each instance a local soil conservation committee, composed of the association's board of directors and representatives of the Soil Conservation Service and the Extension Service, will develop local land-use policies and farm management principles. This program must bear the approval of the State advisory committee.

Committees will also be set up to promote membership and the signing of contracts, to study farm management practices as related to erosion control, to coöperate with forestry officials and those interested in the preservation of wild life, to purchase heavy machinery or other needed materials or equipment, to keep accounts and records and collect fees, to foster educational work and to perform other essential duties.

PASTURES BROUGHT BACK

Here are shown contour pasture furrows being constructed on a farm in the Plum Creek drainage area of Nebraska.

They were built in March with a plow and Corsicana terracer on a native pasture as part of a plan to restore overgrazed pastures in this area by contouring and pasture management.

These particular furrows were planted to a grass mixture immediately, and the area fenced to protect from grazing. As this is written, the new grass is becoming established and will soon be seeding the space between the furrows.

About 380 acres of pastures in the area will be furrowed this year.

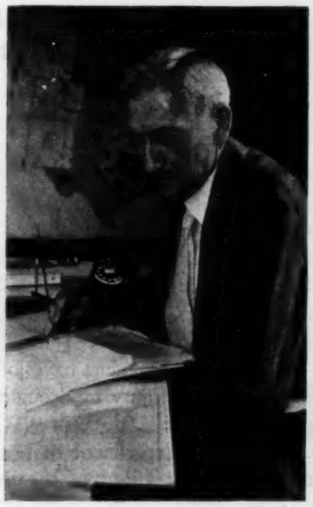
DR. CURTIS F. MARBUT

In Appreciation

The passing of Dr. Curtis F. Marbut, Chief of the Division of Soil Survey of the Bureau of Chemistry and Soils, is felt keenly by the Soil Conservation Service.

He was the leader of soil science in the United States and one of the outstanding pioneers in that science in the world. The present concept of soils in the United States has been molded under his guidance. He enriched and molded the field of thought appertaining to soil science by his own fundamental contributions and by pointing out to others the direction for their thoughts and investigations. It has been due to his leadership that soil science has become one of the foremost fields for research. It has been due to his basic and fundamental contributions to soil knowledge that soil utilization and soil conservation are recognized today as dominant in the life of the Nation.

Many in the Soil Conservation Service have been personally associated with Dr. Marbut, some closely, some but infrequently, and others only by the ties of leadership in thought or action. But all who have been associated with him in any capacity feel that Fortune bestowed a signal honor upon each who was so privileged.—THE STAFF.



"One of the outstanding pioneers"

BRAILLE MAP MADE FOR BLIND MAN

"Seeing is believing", say farmers of the Bear-Deer Creek Watershed near Spring Valley, Minn., when they see the effectiveness of strip cropping, terracing, gully fills, and other measures in checking soil losses caused by erosion. Stewart Warren, however, believes without seeing. For 15 years he has carried on his farm operations in darkness.

His farm of 91 acres is divided by a creek which wanders pleasantly through the meadow until rains convert it into a destroying torrent. In the last 20 years a deep gully has eaten into the land above the meadow and a series of finger gullies have been reaching into the grain fields. Last year it was impossible to drive a wagon into the corn field and the corn had to be carried in bushel baskets across the gulch.

Mr. and Mrs. Warren, well aware of the damage erosion was doing to their land, were anxious to cooperate in checking it.

Nail Holes Indicate Lines

In order that the blind owner might better understand the contours and strip planting of his farm, a crude Braille map was drawn from the aerial picture to the scale of 1 inch to 150 feet. The lines of the contours were indicated by small nail holes close together while the boundary and fence lines were indicated by perforations farther apart. With this map as a guide, Mr. Warren is able to read his contour strips more readily than the average farmer.

The farm has been reclaimed by terracing, strip cropping, and structures built to prevent reopening of the main gully which was sloped down and incorporated into the permanent meadow. The finger gullies have been filled and the terraces with sodded outlets now protect the land from above. Three acres of the steepest hillside have been planted to trees.

Nursery work in cooperation with State establishments has been started in Nebraska, Kansas, Texas, Alabama, and New York.

"THEY CAME THROUGH"—SURVEY SHOWS WHERE DROUGHT MET MOST RESISTANCE

By D. A. Savage [1]

Hardy native grasses constitute our main reliance in the task of covering anew millions of acres in the Great Plains region. We look to such plants as buffalo grass (*Buchloë dactyloides* (Nutt.) Engelm) and blue grama (*Bouteloua gracilis* (H. B. K.) Lag.) to check blowing by wind and washing by flood and to restore pasture value to lands grown unproductive under continuous cultivation.

Buffalo and blue grama have long been considered immune to fatal injury by drought. This conclusion is refuted by studies made in 1934 by the Fort Hays, Kans., Branch Experiment Station, which revealed a large percentage killed in the disastrous season of 1933–34.

In May and June this year, the studies were extended to other stations in the Plains. A detailed ecological survey was made in the western part of the central Great Plains to determine the native grasses which survived, the weeds which lived through and the percentage of ground cover supplied by each species of vegetation.

This work was conducted by the nurseries of the Soil Conservation Service in cooperation with the Divisions of Forage Crops and Diseases and Dry Land Agriculture of the Bureau of Plant Industry, and the State experiment stations.

Method of Charting

A total of 643 meter quadrats, representatively located, were charted with pantographs to show the ground cover of all native grasses and other perennial or turf-forming vegetation on closely grazed pastures, moderately grazed pastures and ungrazed areas, on all of the major types of soil prevailing in the vicinity of Hays, Colby, Garden City, and Tribune, Kans.; Woodward, Okla.; Dalhart, Tex.; Akron, Colo.; and North Platte, Nebr.

Each chart was reduced to an area one twenty-fifth that of a square meter by a lineal ratio of 5 to 1. The charts are now being measured with planimeters to determine the actual percentage of ground cover occupied by each kind of vegetation. Considerable time will be required to complete this work and to compile the data. It will be impossible to announce definite results until these calculations are made. Meanwhile, this preliminary report of general observations made at each station and while traveling between stations will serve to indicate the present condition of the pastures.

Buffalo Grass on Heavy Soils

Buffalo grass was the principal component of the native grasses on the heavy soils throughout the region. The basal cover of this grass was equaled by that of blue grama on the semiheavy soils and was exceeded by the latter on the semisandy soils. Only a few scattering plants of buffalo grass were found on the very sandy soils. Blue grama appeared to be adapted to a much wider range of soil conditions. It occurred in varying amounts on every texture of soil, from extremely heavy to very sandy. Even on the latter soil it often represented a considerable percentage of the vegetation.

Western wheat grass (*Agropyron Smithii* Rydb.) and wire grass (*Aristida purpurea* Nutt.) were interspersed with buffalo grass and blue grama on the heavier types of soil. The sandy land grasses consisted of an association of several or all of the following grasses: Blue grama, side-oats grama (*Bouteloua curtipendula* (Michx.) Torr.), little bluestem (*Andropogon scoparius* Michx.), big bluestem (*Andropogon furcatus* Muhl.), switch grass (*Panicum virgatum* L.), sand reed-grass (*Calamovilfa longifolia* (Hook) Scribn.), wire grass, sand dropseed (*Sporobolus cryptandrus* (Torr.) A. Gray), needle grass (*Stipa comata* Trin. and Rupr.), blow-out grass (*Redfieldia flexuosa* (Thurb.) Vasey), and several other grasses of lesser importance.

Grazing an Important Factor

Grazing not only aggravated the injury by drought but appeared to have materially affected the relative amounts of the different grasses present. Although close grazing was probably detrimental to all of the grasses, it was less injurious to blue grama and still

[1] This is a preliminary report by the assistant agronomist, Division of Forage Crops, Bureau of Plant Industry, Hays, Kans., Experiment Station.

less to buffalo grass than to any of the others. The ground cover of buffalo grass often exceeded that of blue grama by a wider ratio on the closely grazed areas and moderately grazed areas than on the ungrazed areas.

Many plants of all native grasses throughout the region were killed by a disastrous combination of intense heat, severe drought, close grazing, and soil blowing. The surviving ground cover varied from zero to about 60 percent, with an average of about 30 percent for Woodward, Okla., and North Platte, Nebr., and about 15 percent for most other localities. The damage varied about as much within a locality as it did between localities and seemed to be directly and positively correlated with the severity of drought, intensity of grazing and proximity to cultivated fields. The heaviest damage was noted on small, closely grazed and severely trampled pastures which had been badly scarified by dust-laden winds from adjacent cultivated fields. The percentage of the bluestems and other taller grasses killed by the drought was greater than that of the predominating short grasses.

Normal Stands Await Rains

On most pastures the grass, though thin, was rather uniformly distributed and appeared capable of regaining normal stands in one season of average and timely rainfall. Other pastures in many localities, particularly the small ones in the vicinity of Dalhart, Tex., and Dodge City and Garden City, Kans., may require three seasons to recover completely. Even the larger pastures did not escape serious injury, although they were not so badly affected by soil blowing. This indicated that soil blowing was, by no means, the only factor which contributed to the death of the plants.

Practically all pastures in the region were heavily infested with a vigorous growth of annual and perennial weeds. This is a condition which seldom occurs to any appreciable extent on typical short-grass grazing land and will, no doubt, materially retard recovery. Many of the more severely damaged pastures contained numerous seedlings of buffalo grass and blue grama, which will hasten recovery if they are not destroyed by grazing, weed competition, or further drought. Short periods of hot winds and dry weather may kill a large number of these seedlings before they become well established.

All quadrats were permanently located so that they could be rechartered in subsequent years to determine the rate and duration of recovery and the succession of growth under different conditions.

Fence Lines Gone

Although water erosion is the main problem on the Plum Creek area in Nebraska, this picture reflects the unusual condition during the past spring, following the 1934 drought.

The drought favored very little vegetation and what did grow was harvested for feed. This left the soil an easy prey to blowing.

For days at a time the wind whipped the dried-out, pulverized particles across the hilltops into fence rows or clumps of Russian thistles.

The fence between the Pelley and Beckwith farms, shown herewith, was covered with silt to a depth of 4 inches. The farmers of this section are now as much concerned with the problem of wind erosion as they are with that of water erosion.

Summary

The immunity of buffalo grass and blue grama to drought has been refuted by studies made at the Hays, Kans., Experiment Station in 1933–34 and in the western part of the Central Great Plains during the summer of 1935.

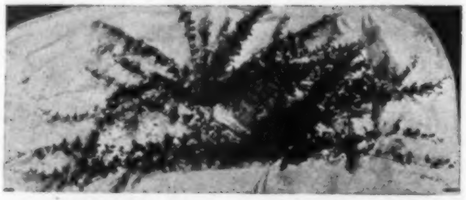
Several hundred quadrat studies taken under various conditions have revealed that drought damage to the grasses seemed directly and positively correlated with the severity of drought, intensity of grazing and proximity of cultivated fields. Heaviest damage was noted on small, closely grazed pastures badly scarified by dust-laden winds.

The surviving ground cover averaged approximately 30 percent for Woodward, Okla., and North Platte, Nebr., and about 15 percent for Hays, Colby, Garden City, and Tribune, Kans.; Dalhart, Tex., and Akron, Colo.

LEGIONS OF LESPEDEZ

By Paul Tabor

Sandy Creek Project, Athens, Ga.



Lespedeza procumbens, a native perennial legume

During the little-known second Spanish period of Florida history, near the year 1800, there was a governor named Lespedez. His political and military deeds were so completely buried with him, that even the name is difficult to find in most American libraries. Despite such historical oblivion, his fame lives on because a botanist, Michaux, gave the name "lespedeza" to a group of purple-flowered native American legumes having one seed per pod.

Other kinds of lespedezas have been found in Japan, China, Korea, and Australia. Some of them have been brought into the Southeastern United States both by accident and by planned introduction, and a few have been amazingly successful. Uncounted billions of these plants are now serving as privates in the battle against soil erosion on both agricultural and waste land. These legions of Lespedez richly deserve a high place in the history of soil conservation.

Native Kinds Perennial

All the native American lespedezas are perennials. There are more than 10 species with upright stems and 2 with creeping or decumbent stems. The stems are renewed from the heavy underground crowns each spring like those of sweet clover and alfalfa.

Seed production is rather heavy but practically all the seed is too hard for good germination. This prevents dense natural stands. Perhaps the use of scarified seed will overcome this difficulty and make it possible for these native plants to take over abandoned or retired fields more quickly and completely. The two species with creeping stems show enough promise at Athens, Ga. to be tested next season as erosion preventing crops.

The introduced or immigrant species of lespedeza include both perennials and annuals. The most promising perennial is *Lespedeza sericea* from China. It has considerable resemblance to alfalfa except that the stems are larger and harder.

Cut Early for Good Hay

A good quality hay can be made by cutting before the stems get woody. A practical biennial or perennial hay crop has been badly needed in the South. Such a crop would make the type of farming there more permanent, would automatically provide more feed for livestock and would do much in soil conservation. *Lespedeza sericea* may fill this need well enough to be widely accepted. It is being extensively introduced by the soil conservation projects of the South. The young plants develop slowly during the first season. To provide a more adequate cover the first year a mixture of annual and *Lespedeza sericea* seed have been sown on the Sandy Creek Project.

Lespedeza bicolor is larger and more woody than *Lespedeza sericea*. It may have a place as an erosion-resisting shrub. Its seed, like those of all other perennial lespedezas, must be scarified if a good germination is to be obtained.

Once Regarded as Weed

The annual species are the most interesting and important. In their native home in Japan and Korea they are regarded as harmless weeds. They are used in Japan for the control of erosion. The common lespedeza found its way into middle Georgia prior to 1846 and during the next 20 years spread widely throughout the South without invitation or assistance from mankind. For more than 40 years it was regarded as a harmless weed. Opinion has gradually changed during the past 45 years until it is now considered a valuable crop. The change started in the 80's in the lower Mississippi drainage basin when it was first grown as a hay crop. In this region the genus name

lespedeza came into common use and has gradually supplanted the popular names, Japan clover and wild clover. It is still known as shamrock in middle Georgia counties where it was first found in this country.

Common lespedeza has several characteristics that make it peculiarly adapted to southeastern United States. It grows well on poor soil, seeds profusely, germinates well, and the young plants endure low temperatures for short periods. Frequently at Athens, Ga., germination has occurred by mid-February and the young plants have endured two or more cold spells with minimum temperatures of about 20° F. Such an early start gives lespedeza a decided advantage over later species of summer plants.

Lespedeza Needs Moisture

The most important limitations of the common lespedeza are its great need for moisture during the early periods of growth and during seeding, and its susceptibility to nematodes. The high moisture requirements, especially during spring, can scarcely be met on thirsty clays or on hill soils where spring droughts are severe. The Athens region is rather dry in the spring for annual lespedeza. The weather man has been generous during the past 2 years, however, and lespedeza is rapidly making gains.

Common lespedeza is highly variable, indicating a complex heredity which is an advantage in securing a relatively wide adaptation to soils and climate. It also furnishes good material for selecting superior strains. The Tennessee Experiment Station has taken advantage of this opportunity and selected a large, fine-stemmed kind known as "Tennessee 76." A larger, coarser kind has been introduced from Japan and named "Kobe." Both have greater possibilities for hay than the common kind if the soil is suitable for high yield.

Korean lespedeza differs enough from the common group to be classed as a different species. It is earlier in growth and seeding and consequently better adapted further north in the United States than the common group of annual lespedezas. The practical southern limit for Korean lespedeza is in the northern half of Georgia and its northern limit in the lower edge of the Corn Belt. In the section between the Cotton and Corn Belts it has contributed greatly to better agriculture and promises to do more in the future.

Firm Seed Bed Required

The seed of annual lespedezas are sown in late winter or early spring, at the rate of 25 to 50 pounds per acre. A firm seed bed is needed to insure sufficient moisture in the root zone of the young plants. Broadcast seeding on grain is common. The seeds need to be covered lightly to prevent heavy rains floating them into depressions and giving an uneven distribution. Best results can be expected by using a weeder or a spiketooth harrow both before and after seeding.

Tall weeds in lespedeza fields are discouraged by slipping high enough with a mower to barely miss the lespedeza tops.

When once well established on a field, annual lespedezas usually reseed naturally. By plowing so the soil is loosened without inverting, leaving the seed near enough the surface to germinate the next season, it is possible to maintain lespedeza in a winter grain-lespedeza rotation for several years.

The lespedezas are now so important in soil conservation through the Southeast and have such possibilities for future development, that our appreciation of them must enchance.

Some ambitious tenant plowed up a pasture on this farm. As a result the top 6 to 8 inches of soil was washed away, leaving the infertile subsoil exposed. The washed portion of the field supports only weeds and a few feeble stems of native grass. The native grass sod above is in good condition, and still intact, though subjected to the same degree of wind and water erosion. This washed-off spot will be reseeded this fall to a mixture of brome, meadow fescue, and orchard grass, and fenced to protect it from livestock until it becomes resodded.

WIND EROSION ON THE SUMMER-FALLOWED WHEATLANDS OF THE WEST

By A. L. Hafenrichter and H. M. Wanser

Pullman, Wash., Project

Once soil begins to drift, the process of wind erosion may go forward unceasingly, like a cancerous growth. It literally defies man's efforts to curb it with physical barriers and extends the boundaries of affected areas with reckless abandon.

Erosion by water affects land directly and progresses with predictable sureness. Erosion by wind has little respect for slope gradients, direction of slope, or adjacent lands lying in any direction from the primary affected area. Wind erosion not only ruins the soil in the field or range where drifting began but increases drift susceptibility on additional areas, sometimes of great expanse, wherever the coarser wind-blown particles come to rest. Run-off water obeys certain fundamental laws with respect to direction of flow, but winds behave with uncertainty.

The wide areas of drifting soil in western America today are a dismal reminder of incorrect land practices. Susceptibility varies greatly with different soil types. It is probable, however, that thousands upon thousands of acres of prairie land were placed under cultivation which were ecologically unsuited for the sustained production of cash crops under intensive and continued cultivation. This becomes particularly evident when drought conditions prevail. Many agencies with a shortsighted motive undertook to move hundreds of sturdy farmers to the frontiers of the West who were accustomed to managing soil only under humid conditions. Thousands of abandoned homesteads, drifted fields, buried fences and inundated roads are monuments to these prodigal practices.

Farms were abandoned in the East for more profitable new land in the West. Water erosion played a part in this movement, only to have the buffeting effect of wind erosion again force abandonment in many instances.

Farming Practices Cause Drift

The story of the causes of drifting soil is essentially no different from that of a water-eroded and gullied slope. When the land was first broken "out of the sod" it did not drift despite intense wind and occasional mild drought years. After some years of crop production, it was found necessary to introduce the practice of summer-fallowing to sustain crop yields, and with it stubble burning became a common practice. Summer-fallowing rapidly depleted the organic matter content of the soil and, though it probably escaped notice, changes in the soil structure resulted.

Slight movement of soil took place, but since there were no perceptible accumulations this received little attention. The loss of the finer soil particles to the atmosphere during the stages of incipient drifting caused no great concern. Under these conditions it is little wonder that the very means by which the soil resisted wind action were rapidly reduced. How striking is the analogy to accelerated water erosion! At the critical point in changed soil structure unfavorable climatic conditions such as "drought years" telescoped the effects that were destined to be realized sooner or later and ruin resulted in a short time. A torrential rain on a denuded slope with impoverished soil does no greater damage than a strong wind acting on mismanaged soil when aided by a deficient moisture supply.

Careless Management

The removal of the grass cover from prairie soils, intensive cash cropping, the burning of stubble, and the practice of summer-fallowing are not alone responsible for drifted fields. The factor is often overlooked that these lands were managed carelessly by people accustomed only to handling soil under humid conditions. Tillage implements were used that left the surface in a finely pulverized condition; as the soil structure changed, this became even more critical in point of resisting wind action. The all-important cloddy surface well mixed with organic debris was not present; when plows, disks, harrows, floats, and drag chains were used, there was a disintegrated dusty mulch at the mercy of even slight wind movement. After serious drifting began, a desirable surface was difficult if not almost impossible to obtain. The damage had been done.

Another striking feature of areas subject to soil drifting is that they invariably bear unmistakable signs of accelerated run-off, especially in regions having summer rainfall. The evidences of accelerated run-off may appear relatively inconsequential but they are unmistakable to the experienced observer. This is surely to be expected, for these soils have nothing that obviates water losses. The essential point is that even relatively minor losses are of tremendous significance.

Control Takes Time

The control of wind erosion must be based on the same fundamentals of soil management as the control of water erosion, for the basic causes are the same even though the agency is different. The essential difference between the two is that the control of soil drifting is a longer, harder, more trying task. To build the soil of wind eroded areas back toward the condition in which nature gave it to us is nothing short of an Herculean task. The very agencies that should be employed to attain permanent results are difficult to use.

The important lesson that must be drawn from long-time experience in wind erosion areas is that there is a very sharp line of demarcation between prevention and control. There must be no equivocation on this point in the summer-fallow country. It is easier, more practical and more economical to prevent wind erosion than to control it.

Proper Tillage Practices

Wind erosion can be prevented in summer-fallow areas by the early use of proper and timely tillage practices. The most important and effective of these are the use of disc plows for the plowing operation, infrequent and timely weeding with rod weeders or weeders that bring clods to the surface, the incorporation of organic matter into the surface, the introduction of grass in a rotation, and the seeding donw of critical blow "spots." Duck-foot cultivators are particularly useful in the northern plains. These methods must be adopted not only where incipient drifting is noted, but where climatic and edaphic conditions make wind erosion likely.

The one-way disc plow, when used in place of the moldboard plow, has proved itself wherever it has been tried. A frequent criticism is voiced against this change since it is believed by some that the disc plow increases drifting. A careful examination of such cases invariably revealed the fact that the plowing was untimely or the disc was used also for weeding. The plowing operation must be done at a time when a pronounced cloddy condition can be obtained. This requires a careful observation of soil moisture conditions. Even with the disc plow, stubble must be worked into the soil and not burned for any reason.

Virgin soil held in place by yucca plants. This shows about 4 feet of the surrounding soil lost. It is in an overgrazed pasture area.

Time, frequency, and manner of weeding the summer-fallow are as important as manner of plowing. A cloddy surface, well mixed with organic residues, must be maintained. The rod weeder used only frequently enough to control weeds is very effective. It leaves clods and residues on the surface and buries the finer particles. Weeding must never be done until the clods have "set" after the plowing operation. Other weeding implements that attain the same result as rod weeders may be used but discs, harrows and "slickers" must never be used.

Permanent Cover Required

In the prevention program, every critical area of soil or topography that tends to drift on a field or farm should be seeded to a permanent grass cover. These are the areas that are the portals of entry for wind erosion.

Along with this a rotation should be introduced that will maintain the organic matter. For many ecological and management reasons, grass is probably the only possibility. The frequency with which it should be grown on a field varies with local conditions, but 10 to 20 percent of the farm should be in grass. This means a considerable adjustment in the wheat-fallow districts when tractors are the chief source of power.

Without question it involves adjustments in land valuation and size of farm; hence, prevention of wind erosion becomes more than an individual problem.

The control of wind erosion, once the soil has drifted, is no simple procedure and involves even greater adjustments than prevention. Among the first points to be decided are what can be used as emergency methods, what must be done to attain permanent control and which lands must be dedicated to a new use. The methods that have been described as useful in preventing drift have merely served to stave off the day of reckoning in areas where the soil has actually drifted. Hence, these may be regarded as emergency measures. To tillage practices may be added ridging, furrowing, strip-cropping, and application of manure. All of these have proved to be emergency expedients of temporary character in the wheat summer-fallow sections. Strip-cropping is also done as a permanent technique in many places.

Circumventing the Wind

Control of wind erosion requires the adoption of more stringent methods than those used for prevention and this is not always easy. Here exacting determination of degrees of drift could be used to considerable advantage provided the classifications are sufficiently elastic to compensate for the recognized idiosyncrasies of wind action. It must be determined which areas must be given over to grazing instead of agriculture to adequately protect them and reduce their effect on adjoining areas. The remaining areas must be treated by a rotation with grass where possible, so that each field is in grass 15 to 20 percent of the time. The difficulty in inaugurating such a program is that a new land-use system must be adopted.

This involves a larger acreage, to attain an economic farm unit and the inclusion of livestock in the farming system. It will be recognized that both changes have far-reaching effects on the agriculture of the Nation; some easily attained, others difficult to accomplish without considerable adjustment. The change must come in a rational land use, commodity adjustment, and erosion-preventing program. For sections that have no grass that lends itself to farm practice, feed crops may be utilized.

In addition to what has been pointed out as necessary to control actively drifting soil, it is always assumed that the most efficient tillage practices will be continued on the land under cultivation. When run-off can be retarded and water conserved, there is no justification for not doing so. In parts of the West receiving little summer precipitation and having sandy loam soils this can largely be taken care of without artificial mechanical controls.

Last spring several "old-timers" in one drift area of the Northwest watched a news reel of wind erosion taking place in another part of the country. They failed to be amazed at the sensational nature of the damage that was being wrought. Afterward they remarked that land in their area drifted like that 15 to 20 years ago until the "poor farmers" were eliminated and then settled down to a persistent conservative type of blowing. Land management in drift areas is an art as well as a profession.

Another class of soil drifting is that for which there is no cure. The only rational solution for the use of such lands is to recognize defeat and set them aside for grazing. These lands must be carefully determined both for the present and for the future. No single agency can accomplish this end by itself. It will require a combination of efforts.

Prevention of wind erosion is a national necessity but control is not certain unless stringent methods are used. Any control other than that inherent in the soil is questionable as a permanent measure.

NEW NURSERIES ESTABLISHED

Nineteen new nurseries will be established by the Soil Conservation Service to meet the pressing demand for trees, shrubs, and grass seed for use on erosion control demonstration projects, according to Charles R. Enlow, acting head of the Division of Nurseries.

This brings the number of nurseries to 83. The coming year will see the production of 600,000,000 trees and shrubs and the collection of 1,000,000 pounds of grass seed not commercially available. The work will go forward in 38 States, on nurseries ranging in in size from 2 to 800 acres.

Special attention is being given to the collection of seed from 25 species of native grasses.

Fifteen of the nurseries will provide materials for the 545 C. C. C. camps under the direction of the Service.

DAMS IMPOUND STATE'S WATER AGAINST TIME OF DROUGHT

By L. C. Tschudy

"The breadbasket of the world"—that's what they called North Dakota in the days when it led the States in wheat production and boasted the leading primary markets for wheat and flax.

But our farmers were not satisfied. They sought to cram still more bushels into the bulging granaries. They went so far as to vote funds for draining sloughs and lakes as they reached out for more and more land to cultivate.

Four years of drought came. The water table dropped to depths where wells no longer functioned. Flowing streams dried up and cattle died of thirst. Water had to be shipped in by train. Winter ice was no longer available. Waterfowl could not find water. City water supplies showed an alarming shortage.

North Dakotans, therefore, rued their loss of water stores and eagerly welcomed the Government's proposed conservation of natural resources. Having no national forests or parks within their boundaries, they found themselves outside the scope of the original Emergency Conservation program. They took an appeal to Washington, convinced the administration of the necessity of holding back the annual spring run-off so as to restore the ground water table to its normal elevation. In May 1933 Emergency Conservation Work to be carried on by the Civilian Conservation Corps in North Dakota was authorized.

Seven Camps Initiate Work

Seven main camps were established in June of that year with F. E. Cobb, State forester, as director of conservation work and A. D. McKinnon as State technician. These camps were administered by the State director and supervised by the United States Forest Service. They were located in North Dakota in the summer and transferred to other States for the winter. During the time these camps were located in North Dakota, 133 dams and three diversion canals were constructed.

The water conservation program was immediately popular and in a short time over 2,700 applications for dams of various sizes were on file in the central office.

Cooperstown Dam, constructed of rubble masonry; length, 50 feet; height, 9 feet; pond area, 45 acres.

When the 1934 program was authorized more permanent structures were requested, and as a result cement was permitted to be purchased. Six C. C. C. camps were set up in May 1934. This number was increased to 14 in the latter part of July, when additional drought-relief camps were established.

A Year's Accomplishment

The different types of structures and the number of each constructed in 1934 follows: 14 rubble masonry overflow, 5 earth fill with rubble masonry spillway, 62 earth fill with mechanical spillway, 21 earth fill with natural spillway, and 3 treated timber crib, making a total of 105 dams constructed in 1934. In addition to this, permanent masonry spillways were built in 60 of the 1933 projects. The total amount of work accomplished in the third period (May to October 1934) was placing 279,439 cubic yards of earth fill, 13,443 cubic yards of rubble masonry, 5,620 cubic yards of rock tee, 68,268 square yards of rock rip-rap, 532,000 board feet of timber and sheet piling, and 2,114 lineal feet of tile pipe.

The water that these dams will store for use in North Dakota would cover 115,607 acres of land to an average depth of 1 foot.

Current Program Under S. C. S.

During the winter of 1934, when the camps had moved to other States, a special appropriation was

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ALL THIS STARTED FROM THE TRICKLE FROM A ROOF

By Leon J. Sisk

Sandy Creek Project, Athens, Ga.

Providence Cave, like some Gargantuan monster, has devoured everything that stood in its path.

A country road has been changed several times, and now a huge gully is approaching the present road from either side. Several homes, a schoolhouse, a church, a cemetery, even the barn from which it had its humble beginning were not spared. All went into its maw to satisfy an insatiable craving. It was, indeed, "hungry as the grave."

The Building of a Barn

Back in 1855 a barn was built on the Patterson farm, out from Lumpkin, in Stewart County, Ga. It was probably a good barn. I have no way of knowing, for it has long since been gone.

I can picture this barn, though—big, solid, and proud as a bank. It was the depository of wealth garnered from the soil. Probably there was a huge loft containing winter feed for the stock. Beneath was stored grain, corn, wheat. At night the silence was broken by the moving of cattle and the stamping of horses. By day it echoed to the shouts of children playing in the haymow or searching for hidden nests of hens.

There it stood, secure and snug. Soon summer had fled, and a hint of frost was in the air. The harvest was over and the barn filled to bursting.

Evenings found the family inside the house grouped about a great open fire. Cider and big red apples were on a table and youngsters were busily popping corn.

The winter rains had begun and outside the rain fell in a steady, typical winter drizzle. And underneath the eaves of the barn a course was established for Georgia's biggest gully.

No Control of Run-Off

If Farmer Patterson had controlled the run-off from the barn when the gully was first beginning, much damage could have been averted. Had terraces been constructed in the vicinity of the barn, had the path taken by the run-off been sown to close growing vegetation, all this desolation could have been averted. But Farmer Patterson did none of these things.

From this small beginning the gully has progressed until today there exists an immense system of gullies, called Providence Cave. This system, with its many "fingers" covers from 50 to 75 acres of land. The

A scene of devastation that is characteristic of the spectacular tragedy wrought by erosion in parts of Stewart County, Ga.

gullies vary in length and depth. Some are from 100 to 200 feet deep and from 100 to 200 yards in width.

Many other gullies are in this same vicinity, some of them approaching Providence Cave in size. Seventy thousand acres of land in Stewart County, once high-grade farm land, have been destroyed by uncontrolled erosion. At one time this section was composed of land as fertile as could be found in Stewart County. Now, by actual planimeter measurements, 32 per cent of 15,360 acres of land in the vicinity of the Cave is unfit for cultivation, being composed of rough, gullied land.

Much of the land is operated by tenants and no attempt has ever been made to stabilize the gully. It has steadily proceeded, increasing in size with each rain. Nothing has impeded its progress.

Not only houses, burial grounds, roads, and the actual ground on which it fed and thrived suffered, but acres upon acres of fertile land were covered with worthless material washed from the gullies, rendering these unfit for cultivation.

Even at this date it can be stabilized, but land that was at one time worth $5 to $20 an acre can never be restored to its former usefulness.

The land where Providence Cave is located could be in valuable timber if proper care had been given at the right time. As conditions are today, timber falls into the caves as they advance. Soil from the caves has dammed up streams below and formed lakes and useless sand areas.

The tragedy is that this, the largest gully in Georgia, which has caused thousands of dollars damage, which would cost thousands more to stabilize, could have been prevented.

ILLINOIS FARM ADVISERS TOUR PROJECT

Ninety-two farm advisers (county extension agents), representing 100 of the 102 counties in Illinois, toured the Sangamon River demonstration area recently and saw with their own eyes what mechanical structures supported by vegetation will do to control erosion. The all-day tour was attended by approximately 200.

The trip was sponsored by the Soil Conservation Service in cooperation with the Illinois College of Agriculture, as part of the annual 3-day program for farm advisers at the university. Several agricultural college faculty members and other farm leaders in the State also were present.

Grasses Effective

The unusually fine growth of grasses and forage crops in the area this spring supplied plenty of evidence to the visitors of the power vegetation has in controlling erosion. Alfalfa, bluegrass, sweetclover, and lespedeza were doing a splendid job of holding the soil in place. One of the farm advisers remarked, "If we could cover the State with a good sod, we wouldn't need any erosion-control program."

But Illinois farmers must till the soil and they must grow corn. The farm advisers are well aware of this and showed special interest in the demonstrations of strip-cropping and contour farming—practices entirely new to most of them.

Interest in Gully Control

The gully dams attracted considerable attention, especially from the advisers of southern Illinois, where gullies are large and numerous. The beneficial effects of grass waterways were seen in several instances.

One example in particular warrants mention here. A livestock farmer, who owns 85 acres of rolling land, established sod in a deep gully when he bought the farm 9 years ago. Today the gully is completely filled. A soil profile taken from the waterway revealed that 42 inches of soil had been deposited in the gully in the

9 years. The profiles which demonstrated this condition impressed the visitors because they had the whole picture right before them—the eroded field, the grass waterway, the profiles and the farmer himself, who related the story.

At the terracing demonstration, which concluded the tour, the visitors had an opportunity to experience some of the difficulty often encountered in educating the farmer to the value of terraces.

Terraces Would Have Prevented This

The demonstration was held on the farm of W. G. McCullough, who owns a section of land and farms with heavy machinery. Last summer our field men agreed to seed alfalfa on a slope which was eroding badly. He did not want terraces. Soon after the alfalfa was seeded, the first week in August, a heavy rain fell and washed many gullies 6 to 10-inches deep and 1 to 3 feet wide. When Mr. McCullough saw what had happened he immediately asked for terraces and was well satisfied when they were built.

Then he wanted terraces built on the opposite slope so that he could sow more alfalfa. It was this terracing that was done as a demonstration for the tour. Before the terracing crews started work, Mr. McCullough stated to the group that he did not believe he could farm with the terraces because of the heavy machinery he used. But when the terraces were completed he said, "Those terraces are not so crooked but what I can farm with them, and I'll do that." He now has a small terracing outfit for his own use.

LARGE DEMAND FOR NATIVE SEED

Approximately 600,000[1] pounds of native grass seed has been requested by the various Soil Conservation Service projects in Kansas, Oklahoma, and Texas for 1936 plantings.

If this were timothy or Kentucky blue as it grows in the north and east, this quantity would not present a difficult problem, but acquiring this much native grass seed will be no mean accomplishment. The amount of seed finally obtained will depend not only upon the agility of the field men, but also upon the eccentricities of the weather.

When grasses form a sod so that each plant is in direct competition with several other plants, seed is formed only during the more favorable years. Getting seed from isolated plants is slow business.

To Specialize in Seed Production

Methods are being tried that appear to have considerable promise. We may find it necessary to plant areas for seed production alone. Such a method is going to be essential in producing some species.

Harvesting and cleaning the seed is another problem confronting us, even after we have found areas of good seed supplies.

[1] This figure has since risen to 800,000.

The average buyer of grass seed is practically unconscious of the fact that somewhere, buried among a mass of trashy material there are some kernels that represent the seed itself. Many assume that 100 so-called seed should represent 100 kernels. It seems that grass seed, even among our cultivated forms, is seldom so obliging.

Results of Study

For example, a study made this year on Dallis grass showed that on an average only 13.5 percent of these hulls had seed in them. Little bluestem, gathered from widely distributed areas of Kansas, Oklahoma, and Texas, produced seed in its glumes ranging from 5 percent up to 38 percent, averaging 14.1 percent for all samples collected. Blue grama averaged 53.1 percent of glumes enclosing caryopses. Switchgrass averaged 40 percent, Big bluestem 12 percent, and Western wheat 41 percent. Buffalo grass, having 2 to 5 spikelets per head or spike, averaged 1.4 seed per head.

Thus, our native grasses, though not as high in quality as a rule as most introduced grasses, are still high enough to be useful for planting purposes. If handled in the same way, they might be induced to produce seed of equal quality.—Excerpt from address by B. F. Kiltz, of the Stillwater, Okla., project, at the Sixth Southwest Soil and Water Conservation Conference, Tyler, Tex.

CLAY DRIFTS OF TULE LAKE SUMP

Sand dunes are a familiar feature of semiarid regions. Clay drifts, being less frequently seen, should prove of special interest. Such drifts have recently been observed on the leased lands of the Tule Lake bed just south of the Oregon-California State line in the Lower Klamath Basin.

The soil on Tule Lake Sump consists of 6 to 18 inches or more of dark, peaty silt loam or muck with 25 to 30 percent organic matter, underlain by a gray colloidal diatomaceous material of silty clay loam, which contains about 15 percent volatile matter. These lands were being cultivated in late April with a water table 18 to 36 inches from the surface, the moisture content of the muck amounting to 100 to 150 percent.

The lakebed lands south of the Government protecting dyke and outside of the bird reserve or sump proper are being leased in large units for extensive grain farming. The rank growth of grain straw, including combine lanes, is eliminated by annual light burning.

Particles Carried by Wind

In places, especially in the shallower peat near the edges of the sump, the plow reaches through the mantle of muck into the underlying chalky subsoil. This material when brought to the surface dries and shrinks, breaking down into small kernels a millimeter or less in diameter. Being lighter than sand, it is readily carried by the wind. Air movement of 15 to 30 miles per hour is not uncommon. Both peat and clay on the loose, cultivated land are easily picked up by the wind.

Small clay hummocks accumulate in numbers and sometimes attain depth equal to the height of stubble near the edge of the marsh.

In the cropped area the land surface is subsiding due to light burning, compacting with heavy tillage implements such as the caterpillar tractor, and extensive farming machinery, and the increased oxidation due to the lowering of the water table. Within the sump proper tules and related growths add several tons of organic material annually, increasing the difference in level and thus accelerating seepage.

It is suggested that over a long period of time it may be found expedient to move the sump or to rotate grain farming with wild game areas in long-time rotations.—W. L. Powers, Oregon Agricultural Experiment Station.

DAMS IMPOUND

(*Continued from page 11*)

granted for 6 survey crews. In all, 149 water-conservation projects were surveyed, designed, and planned for the 1935 construction season.

In April 1935 the water conservation work in North Dakota was transferred from the United States Forest Service to the Soil Conservation Service. Seven camps are now being occupied by the C. C. C. personnel in North Dakota, under the jurisdiction of the Soil Conservation Service. They are engaged in building small dams and some level terraces. These camps are located at Wishek, New England, Valley City, Park River, Mandan, Lakota, and Watford City. About 50 structures should be completed by October 1935.

SOILS SCIENCE

(*Continued from page 1*)

sessions. An opportunity was thus provided for prepared discussion. Papers were presented in English, German, or French.

Experiment Long Under Way

The agricultural experiment station of Rothamsted, which boasts of a field experiment in wheat growing that has run continuously for 90 years, held special interests for the delegates. It was fitting that the congress should have been held in England and in Oxford, as well. The University of Oxford was founded during the reign of Henry II of England (1154–89) nearly 800 years ago—Oxford, a famous seat of learning, the cradle of "causes", the foster mother of literature, arts, and sciences. From Roger Bacon, 1214–92, the first great Oxford name in science to the present, Oxford has played a leading role in the development of the sciences. Although generally known for cultivation of the arts, the University authorities early recognized agriculture as a subject for higher learning in the foundation of the School of Rural Economy (Schola Economiae Rusticae) in 1796. This, with the School of Forestry founded in 1905, and the Imperial Institutes of Agricultural Engineering and Forestry, supplied traditions and interests favorable to the deliberations of a congress in soil science.

Appropriate Setting

Delegates were introduced into many features of the simple and venerable way of living of students at Oxford, by being lodged in student suites of rooms off the staircases of the colleges. The headquarters for the congress were located in the buildings of Wadham College. The famous towers of Oxford, and their bells and chimes, and the striking of Old Tom (the great bell of Christ Church College tower), created a beautiful setting for deliberations of a scientific congress.

It is impossible to notice within the limits of these impressions all important contributions made to pedology at the Congress. Only a few may be referred to briefly. The proceedings may be consulted with profit to specialists in the various fields of soil science.

Papers disclosed that soil mapping has rapidly received general attention and is contributing important services to agricultural developments in many countries. Soil mapping is now generally recognized as a necessary preliminary to agricultural developments. The soil map of Europe prepared by Professor Stremme and collaborators is a good example, as well as the preliminary soil maps of Africa.

Studies of Soil-Plant Relationships

Soil-plant-moisture relationships have received extensive study. Accordingly, the paper by Dr. R. K. Scofield proposing to express these relationships in thermodynamic terms and to measure the effectiveness of soil moisture for plants by means of a logarithmic scale—a pF scale—was received with special interest. Alike with the pH scale of soil acidity, the pF for moisture effectiveness represents a definite step in studies and measurements of soil-plant relationships.

In soil chemistry the recognition of calcium, sodium, magnesium, and hydrogen clays marks a distinct advance in an understanding of soil characteristics and in soil management for crop production. The work of Dr. Hissink on the Zuyder Zee reclamation is in point.

The field of soil biology is perhaps the most alluring in its appeal. The variety of organisms, their interrelations and activities in the nitrogen cycle is still as incompletely explored as the jungles of the upper Amazon Valley. The variation in numbers of bacteria from day to day, and even from hour to hour, leaves bacterial count of little significance. There has been disclosed in this bacterial jungle of the soil another law of "tooth and claw", protozoa, particularly amoeba, feeding upon bacteria and finding some more delectable than others. Antagonisms between certain strains of soil actinomycetes have been shown by G. Samuel; others intermingle. Cutler showed that relative efficiency of organisms may vary inversely as their numbers. Can this be also a case of overpopulation? And interestingly enough, nitrifying organisms go in tribes, whose allegiances are selective, to their appropriate leguminous plants. Three strains or tribes of *Bacillus radicicola*, otherwise indistinguishable, have been found by Thornton to affect the clover plant favorably, indifferently or unfavorably. The bacterial tribe most favorable to the clover plant prevails over its rivals, and opens up a field of possible directive control and improvement of pasture crops.

Plants Vary Requirements

Plant nutrition, estimation of plant foods within a soil, resembles an incompletely explored continent. While progress has been made, as reported by Mitscherlich, a number of baffling problems remain unsolved. Sir E. J. Russell forecasts the establishment of a scale of the amount of available plant food in the soil similar to the pH of acidity, and the pF of available water. Certain propensities of plants to vary their requirements may further complicate the problem. Papers on this phase of soil science will be read with renewed interest in this baffling problem.

Deterioration of the physical condition of soils in the loss of aggregate forming organic matter has been shown to account for susceptibility of soils to wind erosion. Attention to problems of soil-wastage by erosion by wind and by water was given more prominence at this Congress than hitherto. It became apparent that the interest in soil erosion varies pretty much with the intensity of this phenomenon in the homeland of the soil scientist. The degree of soil erosion and its menace to sustained productivity of soils is dependent in large measure upon the type of prevailing rainfall. Large continental areas which give rise to thunderstorms or convectional type of rainfall, suffer most acutely from erosion losses on cleared and cultivated fields. Thus, soil scientists of Africa, south and east, of India, and of China, understood more fully the problems of soil erosion and its control as reported by the writer for the United States.

The significance of the coming together of students of soil, its conservation and management, from the leading countries of the world is far-reaching. At such conferences problems affecting the welfare of humanity, rather than exclusively of a single national area, are discussed in the candor of scientific inquiry. A groundwork for international cooperation in the victualing, clothing, and provisioning of the peoples of the earth is being firmly laid in studies of the basic resource—the soil. Foundations are thus being laid for a structure of the future, whose dimensions and inclusiveness can now only be a subject of speculation.

PREVENTING BARNYARD GULLIES

By R. B. Hickok

Salt Creek Project, Zanesville, Ohio

In many of the hill sections of the country the farmsteads are often nestled against the side or at the foot of a steep slope. In former days abundant springs induced the pioneers to build on these picturesque sites where they were afforded protection from the winter winds and snows.

With the clearing of the forests, these slopes ceased to be protective and are now, in many cases, destroying the fertile land which lies below them. The denuded slopes shed the rain that falls upon them, and send it cascading down through the draws and gullies, in debris-laden streams, onto the farmsteads and outwash areas at their bottoms.

Farmyards Flooded

As a result, many farmyards have been swept clear of top soil and the continual tramping of livestock has left them beaten and barren. The buildings are often flooded by these run-off waters, which chisel their courses down through the richest cultivable land and pastures.

Ultimate control of these waters must extend to their source and will be brought about by the reestablishment of vegetative cover on the tops and sides of the hills and knobs.

In some instances diversion channels have been constructed across slopes to intercept run-off approaching farmsteads and carry it safely away to a vegetative outlet. These channels have the appearance of, and are constructed similarly to, a large terrace. They are usually large because great quantities of water must be handled. They are constructed with gentle grades to carry the water at low velocity to the outlet. It is expected that the channels and fill-banks will become sodded. In most cases the channels have been designed for maximum velocities of about 5 feet per second. The channels are seeded and temporarily fenced from livestock.

In some situations a small amount of protection of the diversion outlet is required. A few simple checks and spreaders may be installed to prevent damage while young trees and grasses are becoming established.

Controlling Gullies

If the farmsteads are located at some distance from the foot of the slope or situated on some of the gentler slopes, the damage is less general and is confined to gullying in the yards and lots. In such cases efforts have been made to control individual gullies by means of simple checks and fills to aid in reestablishing vegetation which has been trampled and washed out. Rock is available in most of the area and has been used extensively in gully control work. It has particularly proved its value in farmyard lots where tramping and close-cropping by livestock make conditions unfavorable to vigorous vegetative growth. The rock has been used to build "headers" at the heads of gullies and for rock and litter fills.

The "headers" are modified loose rock dams placed near the lip of the gully and filled from the crest of the dam back to the lip with loose rock and litter. Below the crest of the dam, loose rock and litter has been banked to form a cascade apron. The litter is considered essential in these structures as it will serve to catch and hold silt which will seal the structure and will make it possible for vegetation to become established among the rock. Effort is made to seed in and around these structures so that grasses will bind the structure in place and assure its success.